

WHAT IS CLAIMED IS:

1. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein a minimum interval $2L$ between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of the second semiconductor layer, is $0.2\text{ }\mu\text{m}$ or more but $2\text{ }\mu\text{m}$ or less.

2. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein the value V of the voltage applied between said surface electrode and said backside electrode divided by a minimum interval $2L$ between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor

layer, is 2 (V/ μ m) or more.

3. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type,
5 said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

10 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the
15 surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part
20 in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said
25 third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second

semiconductor layer, is $2L$ (m), a carrier density of said second semiconductor layer is N (m^3), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$D^2 + L^2 \leq 3.0(1+V) \times 10^9/N.$$

4. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface

of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

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$$D^2 + L^2 \leq 6.0(1+V) \times 10^{-13}.$$

5. A photocathode for emitting electrons in response to incident light, comprising:

15 a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

20 a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

25 a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), a carrier density of said second semiconductor layer is N (m^3), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$L^2 \leq 3.0(1+V) \times 10^9/N.$$

6. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third

semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

5 an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

10 wherein, when a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), and the voltage applied between said surface electrode and said backside electrode is V (V), said photocathode satisfies the following relationship:

$$L^2 \leq 6.0(1+V) \times 10^{-13}.$$

7. A photocathode for emitting electrons in response to incident light, comprising:

20 a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive type provided on the first surface of said semiconductor substrate;

25 a second semiconductor layer of the first conductive

type provided on said first semiconductor layer;

a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), and a carrier density of said second semiconductor layer is N (m^3), said photocathode satisfies the following relationship:

$$D^2 + L^2 \leq 3.3 \times 10^{10} / N.$$

8. A photocathode for emitting electrons in response to incident light, comprising:

a semiconductor substrate of a first conductive type, said semiconductor substrate having a first surface and a second surface opposing the first surface;

a first semiconductor layer of the first conductive

type provided on the first surface of said semiconductor substrate;

a second semiconductor layer of the first conductive type provided on said first semiconductor layer;

5 a third semiconductor layer of a second conductive type provided on said second semiconductor layer, said third semiconductor layer having a shape such that a part in the surface of said second semiconductor layer is exposed;

10 a surface electrode provided on said third semiconductor layer;

an active layer, for reducing the work function of said second semiconductor layer, provided on the exposed part in the surface of said second semiconductor layer; and

15 a backside electrode provided on the second surface of said semiconductor substrate,

wherein, when a thickness of said second semiconductor layer is D (m), and a minimum interval between parts of said third semiconductor layer, facing each other while sandwiching the exposed part in the surface of said second semiconductor layer, is $2L$ (m), said photocathode satisfies the following relationship:

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$$D^2 + L^2 \leq 6.6 \times 10^{-12}.$$